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Title: SUCTION HOUSING FOR ROTOR/STATOR PUMP

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PATENT

UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR U.S. LETTERS PATENT

SUCTION HOUSING FOR ROTOR/STATOR PUMP

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SUCTION HOUSING FOR ROTOR/STATOR PUMP

FIELD OF THE INVENTION

This invention relates generally to pumps of the rotor/stator type such as used for cementitious material and is particularly directed to an improved suction housing and other improvements for use in a rotor/stator-type pump.

BACKGROUND OF THE INVENTION

Pumps are commonly used for directing cementitious material, such as of the grouting type, to the location of use of the material. The cementitious material is typically transported and injected under pressure by means of a progressing cavity-type pump comprised of a helical rotor rotating within an elongated, contoured stator which is internally lined with an elastomer. A relatively compact, closed chamber known as a suction housing is disposed between and connects the input end of the rotor/stator combination with a conventional drive arrangement incorporating a motor with a rotationally displaced drive shaft. The closed suction housing is adapted to receive the wet cementitious material such as under a hydrostatic head and deliver it to the input end of the rotor/stator combination in a manner which eliminates the possibility of foreign material entering the pump during the pumping process. Pumps used for these applications are known as "closed throat" type pumps, and are available from various manufacturers. Pumps of this type direct the cementitious material to the location of application which frequently affords only limited accessibility.

Referring to FIG. 1, there is shown a partially cutaway perspective view of a prior art rotor/stator pump 10 which the present invention provides various improvements over. The rotor/stator pump 10 is generally in the form of an elongated, hollow tube and includes an

inlet/drive stage 14 and a pumping stage 17. The inlet/drive stage 14 and pumping stage 17 are connected to various mounting/support brackets 11a, 11b and 11c which provide stable positioning for the rotor/stator pump 10 and allow it to be connected such as by bolts to a support structure which is not shown in the figure for simplicity. The inlet/drive stage 14 is comprised of a bearing housing 15 and a suction housing 19 which in the arrangement shown in FIG. 1 is formed as a single cast piece preferably comprised of aluminum. Disposed within and extending from the bearing housing 15 is a drive shaft 18 which is connected to a source of rotary power which also is not shown in the figure for simplicity. Disposed about and engaging the drive shaft 18 within the bearing housing 15 is the combination of a thrust bearing 20 and a radial ball bearing 22 to facilitate rotational displacement of the drive shaft. Also disposed about and engaging the drive shaft 18 and located generally within the suction housing 19 is the combination of a packing gland 24, packing 26 and a lantern ring 28 which form a seal between the suction housing and inlet/drive stage 14. Other conventional components are disposed within bearing housing 15, but are not discussed herein as these components are well known to those skilled in the relevant arts.

Attached to the suction housing 19 is an apertured inlet flange, or collar, 16 through which a wet cementitious material is deposited into the suction housing for introduction into a stator frame, or transport tube, 12. Cementitious material introduced into the suction housing 19 via inlet flange 16 typically flows under the influence of a hydrostatic head arising from the weight of the cementitious material. Drive shaft 18 is connected to an inner end hub of a rotor 32 within the suction housing 19 by means of a connecting rod 30. Opposed ends of the connecting rod 30 are pivotally coupled to the drive shaft 18 and the inner end hub of rotor 32 in

a pivoting manner which allows the rotor hub to follow an elliptical path as it is rotated by the drive shaft 18. Connecting rod 30 thus imparts rotation to rotor 32, while allowing the rotor hub to follow an elliptical path above the axis of rotation. As rotor 32 is rotationally displaced, cementitious material is drawn out of the suction housing 19 and into the space between the rotor 32 and stator 34 and is displaced along the rotor/stator combination for discharge through an aperture 36 in the distal end 12a of the stator frame 12. A bolt 23 disposed in a lower portion of the suction housing 18, when removed, allows for discharge during cleaning of residue remaining within the rotor/stator pump 10 following use. Cleaning of the rotor/stator pump 10 after each use is essential for continued pump operation because of the cementitious composition of the material introduced into and displaced by the pump, but is very difficult to carry out in this prior art pump.

These types of pumps suffer from three basic recurrent problems. The problems arise from the limited access afforded by the pump's closed suction housing. First, pumps of this type are difficult to clean and maintain, as well as to disassemble for inspection or repair. For example, when the rotor is turning, its hub describes an elliptical path. Thus, a connection between the rotor's hub and an input drive shaft requires that this type of motion be accommodated. In the standard pump design, this is accomplished by means of a connecting rod disposed within a tubular drive shaft, one end of which is pinned to an end of the tubular drive shaft, while a second opposed end of the connecting rod is pinned to an end of the rotor hub. The connecting rod imparts rotation to the rotor, while also describing the elliptical path of the rotor hub. The standard design leaves the end of the drive shaft open and exposed to the product being pumped. This allows some of the product deposited in the suction housing to enter an end

of the drive shaft. Because the product is a cementitious material, it often forms a solid mass within the drive shaft. This renders the connecting rod immobile resulting in excessive stator wear, and makes disassembly of the pump for inspection and/or maintenance difficult, if not impossible. This unfortunate situation also invariably results in reduced pump operating lifetime.

The present invention addresses the aforementioned limitations of the prior art by providing an improved suction housing for a rotor/stator pump used with cementitious materials which is easily disassembled to facilitate cleaning, inspection and repair of the pump. This invention also contemplates additional improvements which increase the reliability and prolong the operating lifetime of these types of pumps.

OBJECTS AND SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an improved pump for cementitious material which is easily cleaned and repaired, has an increased operating lifetime, and is of simplified design and construction.

It is another object of the present invention to provide a suction housing for a rotor/stator pump which is easily disassembled to provide access to a drive shaft/rotor combination to facilitate pump cleaning and repair.

Yet another object of the present invention is to provide lubrication for the moving parts of a rotor/stator pump for increasing pump reliability and extending its operating lifetime.

A still further object of the present invention is to provide increased operating flexibility for a rotor/stator pump such as for cementitious materials for use in a wide range of operating environments.

This invention contemplates an improved suction housing for use in a progressing cavity

pump of the rotor/stator type having removable panels which facilitates cleaning and maintenance of the pump as well repair or replacement of worn or damaged pump components. This invention further contemplates lubricating the pump's drive shaft for improved pump reliability and longevity, while allowing cementitious material to be delivered to the location of application with greater positioning flexibility than heretofore available.

BRIEF DESCRIPTION OF THE DRAWINGS

The appended claims set forth those novel features which characterize the invention. However, the invention itself, as well as further objects and advantages thereof, will best be understood by reference to the following detailed description of a preferred embodiment taken in conjunction with the accompanying drawings, where like reference characters identify like elements throughout the various figures, in which:

FIG. 1 is a partially cutaway perspective view of a prior art rotor/stator pump;

FIG. 2 is a partially cutaway and exploded perspective view of a rotor/stator pump in accordance with the principles of the present invention;

FIG. 3 is a longitudinal sectional view of the inventive rotor/stator pump shown in FIG. 2;

FIG. 4 is an upper perspective view of a suction housing for use in a rotor/stator pump in accordance with one aspect of the present invention, where one of the suction housing's cover plates has been removed to illustrate additional details of the invention;

FIG. 5 is a partial sectional view of the inventive rotor/stator pump illustrating details of the manner in which a sealed connection is provided between the pump's drive shaft and the rotor's hub; and

FIG. 6 is a sectional view shown partially in phantom of the suction housing

contemplated for use in a rotor/stator pump in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 2, there is shown a partially cutaway and exploded perspective view of a rotor/stator pump 50 in accordance with the principles of the present invention. FIG. 3 is a longitudinal sectional view of the inventive rotor/stator pump 50 shown in FIG. 2, while FIG. 4 is a perspective view of the inventive rotor/stator pump illustrating additional details of its suction housing 56 and lubricant reservoir 66.

As in the previously described prior art approach, rotor/stator pump 50 includes a stator frame 52 and a bearing housing 60. The rotor/stator pump 50 includes plural pump mounting/support brackets 58, although only one such bracket is shown in FIG. 2 for simplicity. The pump mounting/support bracket 58 is attached to the bearing housing 60 by conventional means such as a clamping structure with attaching bolts as shown in FIG. 2. Disposed between and attached to the stator frame 52 and bearing housing 60 is a suction housing 56. Suction housing 56 is attached to a first input end of the stator frame 52 by means of a threaded end portion 52a on the stator frame. Suction housing 56 is further connected to an end of the bearing housing 60 by means of a coupling flange 82 as described in detail below.

Stator frame 52 and bearing housing 60 and the contents thereof are conventional in design and operation. Thus, stator frame 52 has an inner surface in the form of a stator 52b incorporating an elastomer and a rotor 54 disposed within the stator frame and extending the length thereof. Bearing housing 60 has disposed therein and extending the length thereof a drive shaft 64. Attached to one end of drive shaft 64 is an adapter 62 for facilitating attachment of the drive shaft to conventional rotary drive means such as an electric, gas or hydraulic motor.

Disposed within the bearing housing 60 and engaging the drive shaft 64 are various conventional components to facilitate rotational displacement of the drive shaft within the bearing housing such as previously described with regard to the prior art rotor/stator pump 10 of FIG. 1 as well as a shaft collar 94 and a packing gland 96 as shown in FIG. 2.

Suction housing 56 includes a front panel 70a and a back panel 70b having attached thereto the aforementioned coupling flange 82 as shown in FIG. 4. Coupling flange 82 is securely connected in a sealed manner to an end of the bearing housing 60 by conventional means such as plural nut and bolt combinations, where only three such combinations are shown in the figures as elements 98, 100 and 102. Suction housing 56 further includes first and second side panels 72a and 72b, and top and bottom panels, where the top panel is shown as element 74a. Suction housing 56 is generally rectangular in shape, with each of the first and second side panels 72a, 72b and top and bottom panels including a respective generally circular aperture therein. Thus, as shown in FIGS. 2 and 3, the first side panel 72a includes aperture 76, while as shown in FIG. 4 top panel 74a includes aperture 78. Each of the aforementioned panel apertures allows for access to the inner portion of the suction housing 56 and the various components disposed therein to facilitate cleaning of the rotor/stator pump 50 and/or repairing or replacing pump components when needed. Each of the first and second side panels 72a, 72b and top and bottom panels includes plural threaded pins therein for attaching a cover plate to the panel. Thus, as shown in FIGS. 2 and 3, the first side panel 72a includes four threaded mounting pins 80a- 80d. Similarly, as shown in FIG. 4, the top panel 74a includes four threaded mounting pins 79a-79d. Each of the aforementioned sets of threaded mounting pins on a respective panel allows a cover plate to be attached to the panel so as to cover the generally circular aperture in

the panel and render the suction housing 56 fully enclosed and sealed. Thus, each of four apertures within a first side cover plate 84a is adapted to receive one of the respective mounting pins 80a-80d for positioning the cover plate on the panel. First through fourth threaded connectors 88a-88d are respectively adapted to engage the first through fourth mounting pins 80a-80d for securely attaching the first cover plate 84a on the first side panel 72a in a sealed manner. Similarly, four threaded mounted pins 79a-79d disposed on the top panel 74a are adapted for insertion within respective apertures in a top cover plate 86a for secure attachment to the top panel by means of four threaded connectors 90a-90d. A second side cover plate 84b and a bottom cover plate 86b are similarly adapted for attachment to the second side panel 72b and the bottom panel, respectively, in a sealed manner.

Referring to FIG. 5, there is shown additional details of the manner in which an intermediate portion of a drive shaft 124 is connected to the hub 126a of a rotor 126 in a sealed manner in accordance with another aspect of the present invention. FIG. 5 is a sectional view of the suction housing 120 taken along the longitudinal center axis A-A′ shown in FIG. 3 of the rotor/stator pump within which the suction housing is disposed. Shown in FIG. 5 is a suction housing 120 in accordance with another aspect of the present invention having an inlet tube 122 attached to a lower portion of the housing to facilitate introduction of cementitious material in the suction housing. Suction housing 120 also includes a side panel 132 having a generally circular aperture 132a therein. The intermediate portion of drive shaft 124 is connected to rotor hub 126a located on the end of rotor 126 by means of the combination of a connecting rod 130 and a connecting rod 128. Connecting rod 128 is also connected to the end of intermediate portion of drive shaft 124 by means of a second connecting pin 136 shown in the figure in dotted

line form. As described above, as the rotor turns, the rotor's hub 126a moves in an elliptical path in a plane transverse to the longitudinal axis of the rotor/stator pump. This dual connecting pin coupling arrangement between the rotor's hub 126a, connecting rod 130 and the intermediate portion of drive shaft 124 allows for elliptical displacement of the rotor's hub. The off-axis positioning of the connection between the intermediate portion of the drive shaft 124 and the rotor's hub 126a is shown in FIG. 3, where the connecting pin 112 between the rotor's hub and the connecting rod 30 is shown disposed below the longitudinal axis center A-A′ of the rotor/stator pump.

Also in accordance with the present invention, there is shown in FIG. 5 a shaft sealing gasket 134 disposed about adjacent portions of the rotor's hub 126a and the intermediate portion of drive shaft 124. The end of the shaft sealing gasket 134 is securely positioned over a drive shaft slot 138 within the suction housing 120 and enclosing the intermediate portion of drive shaft 124. Shaft sealing gasket 134 prevents cementitious material deposited in the suction housing 120 from entering an end slot 126b within the rotor's hub 126a and from coming in contact with various pump components such as connecting pin 130 and connecting rod 128 connecting the intermediate portion of drive shaft 124 to the rotor's hub. Thus, this connection between the intermediate portion of drive shaft 124 and the rotor's hub 126a does not have to be cleaned out after each use of the rotor/stator pump. This sealed arrangement for the aforementioned drive components of the rotor/stator pump also increases the reliability and prolongs the operating lifetime of the rotor/stator pump.

Referring to FIG. 6, there is shown a sectional view of suction housing 140 in accordance with the present invention illustrating additional features of the suction housing. Suction housing

140 includes a side panel 142 having a generally circular aperture 142a therein as previously described. Each of the top and bottom as well as the two lateral surfaces of the suction housing 140 are provided with four threaded slots for receiving threaded mounting pins for attaching a respective cover plate to each of these outer surfaces of the suction housing. Four of these threaded slots 146a-146d are shown in dotted line form in the sectional view of FIG. 6. Also, a front portion of the suction housing 140 is provided with an enlarged threaded aperture 144 for receiving a threaded end of the stator frame which is not shown in the figure for simplicity.

Disposed on an aft portion of suction housing 140 is a coupling flange 150 for connecting the suction housing to a bearing housing also as previously described. Plural threaded slots 152a, 152b and 152c are provided in the coupling flange 150 for connecting the suction housing 140 to the bearing housing (not shown for simplicity). A fourth threaded slot is provided in the coupling flange 150 for this purpose, but is not shown in FIG. 6 for simplicity. Also disposed within the coupling flange 150 is a larger, generally circular slot 156, within which the drive shaft is disposed and which is adapted for also receiving aforementioned conventional components such as a lantern ring and packing rings for forming a seal between the suction housing 140 and a bearing housing to which it is attached. To facilitate rotation of a drive shaft extending through these various sealing components within the coupling flange's circular slot 156, a lubricant reservoir 160 is connected to the coupling flange 150 by means of a threaded connection. Lubricant reservoir 160 includes a connecting tube 160a having a threaded distal end to facilitate connection to a lubricant slot 154a within the coupling flange 150. Three additional lubricant slots are provided for within the coupling flange 150 to accommodate various orientations of the suction housing 140 during operation, where two of these additional

lubricant slots are shown as elements 154b and 154c in FIG. 6. Lubricant reservoir 160 is disposed on an upper portion of the coupling flange 150 to allow lubricant to flow into the coupling flange's circular slot 156 during pump operation. Lubricant reservoir 160 provided lubricant to the aforementioned sealing components such as the lantern and packing rings to facilitate rotation of the drive shaft within the suction housing's coupling flange 150. Elongated, linear slots 158 in the coupling flange 150 are each aligned with a respective lubricant slot to permit lubricant to be distributed over the full width of the lantern ring and plural adjacent packing rings. Finally, a threaded member such as a bolt is inserted in each of the lubricant slots not connected to the lubricant reservoir 160, as shown for the case of threaded member 162 connected to lubricant slot 154b, to prevent leakage of lubricant from the suction housing's coupling flange 150.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the relevant arts that changes and modifications may be made without departing from the invention in its broader aspects. Therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.